CLAIMS

1. A resonance control apparatus for driving a resonant device having a resonance characteristic, the resonant device functioning as a resonant sensor, the apparatus comprising:

a reference signal generating section for generating a reference signal having a predetermined frequency in response to a voltage signal that is inputted into the reference signal generating section;

a divider which divides the predetermined frequency of the reference signal generated by the reference signal generating section to output a signal having a given frequency;

a phase reference forming section which delays a phase of the signal outputted from the divider for a predetermined interval;

a voltage comparator for comparing a voltage of the output signal from the resonant sensor with a predetermined voltage, the resonant sensor detecting the driving state of the resonant device in synchronization with the driving of the resonant device;

a phase comparator for comparing the phase of the signal outputted from the voltage comparator with the phase of the signal outputted from the phase reference forming section; and

a duty control section for controlling a duty ratio of the drive signal provided for the resonant device based on the reference signal outputted from the reference signal generating section.

2. The apparatus as claimed in claim 1, further comprising a low-pass filter which cuts out a high frequency component of the output signal from the phase comparator wherein the output signal from the low-pass filter constitutes the voltage signal inputted into the reference signal generating section.

3. The apparatus as claimed in claim 1, wherein the phase reference forming section is constructed so as to be capable of selecting either a rising edge or trailing edge of the signal delayed in the phase reference forming section when the phase comparator compares the phases, based on the duty ratio of the drive

signal controlled by the duty control section.

4. The apparatus as claimed in claim 1, wherein the duty control section drives the resonant device with the duty ratio in the range of either 10%-50% or 50%-90%.

5. The apparatus as claimed in claim 1, wherein the output signal from the resonant device corresponds to a resonant frequency of the resonant device, and the frequency of the drive signal outputted from the duty control section is controlled so as to be equal to the resonant frequency.

6. The apparatus as claimed in claim 5, wherein the apparatus carries out the PWM control for the resonant device based on the duty ratio of the drive signal controlled by the duty control section.

7. The apparatus as claimed in claim 6, wherein the PWM control is carried out so as to maintain the resonant frequency of the resonant device.

8. The apparatus as claimed in claim 1, further comprising a first phase correction section arranged between the voltage comparator and the phase comparator, the first phase correction section correcting the phase of the signal outputted from the voltage comparator to output the phase-corrected signal to the phase comparator.

9. The apparatus as claimed in claim 8, further comprising a second phase correction section for correcting the phase of the output signal from the duty control section in response to the phase of the resonant frequency of the resonant device.

10. The apparatus as claimed in claim 1, further comprising a second duty control section having a function same as the duty control section, the second duty control section being arranged in parallel with the duty control section;

wherein the two duty control sections are respectively provided for normal drive and reverse drive of the resonant devices, and can control the duty ratios of the drive signals for normal drive and reverse drive either independently or jointly.

11. The apparatus as claimed in claim 1, further comprising at least one duty control section having a function same as the duty control section arranged in parallel with the duty control section;

wherein at least two duty control sections among the duty control section and the at least one duty control section are provided for normal drive of the resonant devices, and can control the duty ratio of the drive signals for normal drive either independently or jointly.

12. A resonance control apparatus for driving a resonant device having a resonance characteristic, the resonant device functioning as a resonant sensor, wherein the apparatus compares the phase of a drive signal for the resonant device with the phase of an output signal from the resonant sensor, which is utilized as a feedback value for the resonant device, and outputs the drive signal to the resonant device in response to the difference between the phases.

13. A method of controlling a resonant device having a resonance characteristic, the resonant device functioning as a resonant sensor, the method comprising the steps of:

generating a reference signal having a predetermined frequency in response to a voltage signal to be inputted, the reference signal being a drive signal for the resonant device;

dividing the predetermined frequency of the reference signal to output a signal having a given frequency;

delaying a phase of the output signal for a predetermined interval;

comparing a voltage of the output signal from a resonant sensor with a predetermined voltage to output a voltage comparison signal, the resonant sensor detecting the driving state of the resonant device in synchronization with the driving of the resonant device; and

comparing the phase of the voltage comparison signal with the phase of the delayed signal to output a phase comparison signal, the phase comparison signal corresponding to the voltage signal to be inputted.

14. The method as claimed in claim 13, further comprising the steps of:

controlling a duty ratio of the drive signal supplied to the resonant device; and

carrying out the PWM control for the resonant device using the duty ratio of the drive signal.

15. The method as claimed in claim 14, wherein the duty ratio controlling step includes respectively controlling duty ratios of two types of drive signals supplied to two resonant devices, which are provided for normal drive and reverse drive of the two resonant devices, based on the reference signal, and the PWM control carrying out step includes carrying out the PWM control for the two resonant devices using the duty ratios of the drive signals.

16. The method as claimed in claim 14, wherein the duty ratio controlling step includes respectively controlling duty ratios of at least two drive signals for normal drive supplied to at least two resonant devices based on the reference signal either independently or jointly, and the PWM control carrying out step includes carrying out the PWM control for the at least two resonant devices using the duty ratios of the at least two drive signals.